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967,445

PATENT SPECIFICATION

DRAWINGS ATTACHED

967,445

Inventors: LEONARD MARK AUGUSTUS GOURD, JAMES HUBERT HENDERSON and WALTER ERNEST TROWBRIDGE

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COMPLETE SPECIFICATION

Electric Arc Torch

We, THE BRITISH OXYGEN COMPANY LIMITED, a British Company of Hammersmith House, Hammersmith, London, W.6, formerly of Bridgewater House, Cleveland Row, St. James's, London, S.W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to electric arc torches for producing a highly heated arc effluent, the arc being struck between a non-consumable rod electrode and an electrically conductive nozzle, and a stream of gas being passed longitudinally of the rod electrode and through the electrically conductive nozzle to produce an arc effluent which may be directed at a workpiece. The invention relates particularly to torches of the above type in which provision made for introducing into the arc effluent material which is to be sprayed onto the workpiece.

According to the present invention, an electric arc torch comprises a generally cylindrical electrically conductive nozzle from the outlet end of which a highly heated arc effluent flows during operation, a member of insulating and heat resisting material adjoining the upstream end of the nozzle, the said member defining a generally cylindrical passage which is coaxial with the nozzle, and the internal diameter of the nozzle being equal to or greater than that of the passage, a non-consumable rod electrode extending through the passage with the arcing tip of the electrode approximately level with the junction of the passage and the nozzle, the diameter of the passage being from one and one-half to four times the diameter of the electrode, and means for introducing into the nozzle downstream of the passage material to be sprayed from the torch.

A torch of this construction may be operated by establishing an electric arc between the electrode and the nozzle and by supplying gas at an appropriate rate of flow through the passage to the nozzle to produce an intensely hot arc which issues from the nozzle. In this effluent may be entrained any suitable material that is to be sprayed onto a workpiece.

The efficiency of the spraying operation of such a torch is largely influenced by the relative dimensions chosen for the passage defined by the insulating member and for the cylindrical nozzle. It is not necessary that the nozzle or the passage should be mathematically cylindrical in shape, and the nozzle may be slightly convergent or divergent, i.e. the nozzle diameter at the outlet or downstream end may be from 90% to 110% of the nozzle diameter at the passage or upstream end.

Preferably the diameter of the nozzle which should not be less than the diameter of the passage is from one to one and one-half times the diameter of the passage, and the length of the passage, which partially determines the "stiffness" or directional stability of the issuing arc effluent, may advantageously be from one-half to one and one-half times the diameter of the passage.

The ratio of the length of the nozzle to its diameter also partially determines the "stiffness" of the effluent, and this ratio should not be so small that the issuing effluent disperses ineffectually over a large area of the workpiece, nor so large that the effluent, in passing from the arc zone to the workpiece, is cooled to an extent that it can no longer supply sufficient heat to the workpiece to effect satisfactory bonding of the material. Preferably the length of the nozzle is from one and one-half to two and one-half times the diameter of the nozzle. The "stiffness" or directional stability of the arc effluent is also dependent on the gas flow rate.

According to the invention, the downstream end or arcing tip of the electrode may

[*Price*

situated level with the junction of the nozzle and the passage defined by the insulating member. However, the apparatus will operate satisfactorily with the electrode withdrawn a little into the passage from this position, or extending a short distance into the nozzle i.e. with the electrode situated only approximately level with the junction of the passage and the nozzle. If the electrode is withdrawn into the passage too far then the heat of the arc will adversely affect even a durable insulating member after quite a short period of operation of the torch and if the electrode extends too far into the nozzle then the directional stability of the effluent may be reduced and the arc may tend to cause severe wear of the nozzle through striking on the nozzle wall near the entry port.

The entry port in the nozzle wall is preferably located near the end of the nozzle adjacent to the passage, since it is desirable that the material introduced into the arc effluent should be fed in as near as is practical to the hottest part of the arc effluent.

The material to be sprayed onto the workpiece is fed to the entry port along a supply pipe, and this supply pipe may be oriented so that the material entering the nozzle through the entry port has an initial trajectory passing through the axis of the nozzle and has a component of motion in the direction of movement of the arc effluent.

The insulating member defining the passage may be provided by a ceramic body having a cylindrical bore, and upstream of the passage the ceramic body may be bored out to a greater diameter to provide a generally cylindrical chamber surrounding the electrode. Gas may be supplied to this chamber which then acts as a reservoir from which gas passes to the passage and thence to the nozzle.

Alternatively, the insulating member defining the passage surrounding the electrode may consist of a cylindrical sleeve of insulating and heat resisting material mounted in one end of a generally tubular metal body. The metal body must then be electrically insulated from the electrode and from the nozzle.

The nozzle may advantageously be a water-cooled copper nozzle.

The dimensions of the passage relative to the non-consumable rod electrode have an effect on the operation of this type of apparatus as a spraying torch, and the diameter of the passage should be from one and one-half to four times the diameter of the electrode.

The diameter of the electrode must be sufficient to carry the desired arc current, and its tip may be tapered if desired.

One construction of apparatus in accordance with the present invention will now be described with reference to the drawing accompanying the Provisional specification. This drawing shows an axial section of part of an electric arc torch suitable for spraying metal powders and refractory materials.

The torch includes a cylindrical body member 10, which is adapted to be attached to the main body (not shown) of a conventional welding torch of the non-consumable electrode type. The body 10 is formed of an insulating and heat-resisting material. A convenient material for this purpose is an aluminium silicate such as that sold under the registered Trade Mark "Alusil". The body 10 has a cylindrical passage 11 bored axially from one end, and this passage broadens out to form a generally cylindrical electrode chamber 21. The chamber 21 is connected, by means not shown which are conventional in gas shielded electric arc cutting and welding torches, with a cylinder of argon gas. A non-consumable rod electrode 12 is mounted axially within this chamber 21 and may be attached to the main body (not shown) of the torch. This electrode is normally made of tungsten. The passage end of the cylindrical body 10 is externally threaded at 22 to receive a threaded retaining collar 19.

A hollow, generally cylindrical nozzle 13 open at both ends is attached to the body 10 by means of this threaded retaining collar 19, so that it is co-axial with the body 10. To prevent the nozzle being damaged by the arc striking to the end of the nozzle in proximity to the passage it is preferred that this end of the nozzle be chamfered as at 25. This nozzle is of the double-walled copper-type, the space 14 between the inner and outer copper walls being occupied by cooling water or other fluid which is fed in by inlet pipe 16 and taken to waste via outlet pipe 15. An entry port 17 is situated close to the body 10 in one wall of the nozzle 13, and a supply pipe 18 passes through both walls of the nozzle 13 to terminate in this entry port 17. Material which is to be heated and sprayed using this torch may be dispensed to the nozzle through the supply pipe 18 entrained in a small flow of argon gas.

Electrical conductors 23, 24 connect electrode 12 and the nozzle 13 to a source of electrical power 20. This source preferably supplies D.C. and its polarity is arranged as shown so that the electrode is negative and the nozzle positive.

Some of the dimensions of important parts of the torch shown in the drawing are as follows:—

Electrode	(12)	Outer diameter :	$\frac{1}{8}$ inch
Passage	(11)	Inner diameter :	$\frac{1}{2}$ inch
Nozzle	(13)	Inner diameter :	$\frac{5}{8}$ inch
Passage	(11)	length :	$\frac{3}{8}$ inch
Nozzle	(13)	length :	$1\frac{1}{4}$ inch

In operation, argon gas is applied to the chamber 21, cooling water is supplied to the nozzle 13, and an arc is established between the tip of electrode 12, which is approximately level with the junction of the passage 11 and the nozzle 13, and the nozzle by any convenient arc-initiating means. Metal or other powder to be sprayed onto a workpiece is introduced into the resulting intensely hot arc effluent via the supply pipe 18. The torch is then held with the outlet of the nozzle a suitable distance, usually $\frac{1}{2}$ to 2 inches, from the workpiece which is to be sprayed, and the arc effluent issuing from the nozzle heats the workpiece and carries the spraying material to it.

A torch according to the present invention has been successfully used to spray a hard surfacing chromium-cobalt-tungsten alloy powder onto aluminium sheet and steel, and aluminium powder or alumina powder onto steel. Coating thicknesses of from $1\frac{1}{2}$ to 8 thousandths of an inch were obtained and the coatings were well bonded to the workpiece.

In spraying these materials, the operating constants were as follows:—

Arc voltage	:	42 volts
Arc current	:	350 amperes D.C.
Gas flow	:	Argon at 150 cubic feet per hour
Electrode negative		

One advantage of an electric arc torch in accordance with the invention is that it may be comparatively light in weight compared with some known arc torches. It can thus be used by the operator for long periods without fatigue. In common with other arc torches, when the gas supplied to the torch is argon (or any other monatomic inert gas) there is no chemical reaction between the material being sprayed and the spraying medium in which it is entrained. This advantage is not possessed by oxygen/fuel-gas spraying torches. The torch has been run continuously for 12 minutes at 350 amperes arc current without deterioration of the electrode 12, nozzle 13, or insulating body member 10. An advantage of this torch over known types in which the powder to be sprayed is introduced into the gas upstream of the rod electrode is that in the torch according to the present invention the rod electrode cannot be fouled or eroded by the powder being sprayed, and there is no possibility that the powder will clog the passage surrounding the electrode. Despite this, the powder to be sprayed can be introduced into the arc effluent only a short distance from its hottest zone.

WHAT WE CLAIM IS:—

1. An electric arc torch comprising a generally cylindrical electrically conductive nozzle from the outlet end of which a highly heated arc effluent flows during operation, a member of insulating and heat resisting material adjoining the upstream end of the nozzle, the said member defining a generally cylindrical passage which is coaxial with the nozzle, and the internal diameter of the nozzle being equal to or greater than that of the passage, a non-consumable rod electrode extending through the passage with the arcing tip of the electrode approximately level with the junction of the passage and the nozzle, the diameter of the passage being from one and one half to four times the diameter of the electrode, and means for introducing into the nozzle downstream of the passage material to be sprayed from the torch.

2. An electric arc torch as claimed in Claim 1, wherein the length of the passage is from one half to one and one-half times the diameter of the passage.

3. An electric arc torch as claimed in Claim 1 or Claim 2, wherein the length of the nozzle is from one and one-half to two and one-half

times the diameter of the nozzle.

4. An electric arc torch as claimed in Claim 1, wherein the means for introducing material to be sprayed comprises an entry port in the nozzle near the passage.

5. An electric arc torch as claimed in Claim 4, wherein a supply pipe to the entry port is oriented so that material entering the nozzle has an initial trajectory passing through the axis of the nozzle and has a component of motion in the direction of movement of the arc effluent.

6. An electric arc torch as claimed in Claim 1, wherein the member defining the passage is formed of ceramic material.

7. An electric arc torch substantially as hereinbefore described with reference to the accompanying drawing.

F. W. B. KITTEL,
Chartered Patent Agent.

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1 SHEET

PROVISIONAL SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale